

RAMP METER

DEVELOPMENT PLAN

District 7
Los Angeles and Ventura Counties



STATE OF CALIFORNIA
Governor Arnold Schwarzenegger

BUSINESS, TRANSPORTATION AND HOUSING AGENCY
Secretary Sunne Wright McPeak

DEPARTMENT OF TRANSPORTATION
Director Will Kempton



DIVISION OF OPERATIONS
OFFICE OF FREEWAYS OPERATIONS
Ramp Metering Branch

July 2005



RAMP METER

DEVELOPMENT PLAN

DEPARTMENT OF TRANSPORTATION

DISTRICT 7

Los Angeles and Ventura Counties

DOUG FAILING
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RAMP METERING BRANCH

July 2005

RAMP METER DEVELOPMENT PLAN

DISTRICT 7

This RAMP METER DEVELOPMENT PLAN, for District 7, has been prepared under the direction of the following registered engineers. The registered Civil Engineers attest to the technical information contained therein and has judged the qualifications of any technical specialists, providing engineering data upon which recommendations, conclusions and decisions are based.

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The Office of Freeway Operations, Ramp Metering Branch, prepares the RAMP METER DEVELOPMENT PLAN, in District 7. The information in this report encompasses all metered and non-metered on-ramps in addition to metered connectors in Los Angeles and Ventura Counties.

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INTRODUCTION

This Ramp Meter Development Plan (RMDP) has been prepared to identify existing metered on-ramps, non-metered on-ramps, and metered freeway connectors in accordance with Deputy Directive (DD-35) and Metering Policy Procedures (See Attachments 3 and 4). This plan includes on-ramps, which are expected to be metered within the next 10 years. In addition, it defines the District's policy regarding the planning and implementation of ramp meters, connector meters and HOV bypass lanes.

The primary objective of ramp metering is to reduce congestion and the overall travel time to motorists on the freeway. Other benefits include enhancing safety by reducing congestion-related accidents and air pollution caused by vehicle emissions.

Since 1969, Caltrans has been implementing ramp and freeway connector metering as an effective traffic management strategy. Metering operates most effectively when traffic is controlled on all inputs leading to a freeway corridor. This control has been accomplished in District 7 by metering freeway on-ramps and freeway-to-freeway connectors.

POLICIES

As stated in Deputy Directive (DD-35), District 7 is committed to using ramp metering as an effective traffic management strategy to maintain an efficient freeway system and protect the investment made in constructing freeways, by keeping them operating under or near capacity flow rates. According to Headquarters' Memorandum dated July 31, 2000, an HOV preferential bypass lane shall be considered at all ramp-metering locations (See Attachment 5). In Addition, a Ramp Meter Design Manual was issued by Headquarters in January 2000, as a uniform guideline for ramp meter design throughout the State.

BACKGROUND

Ramp metering has been operating in the Los Angeles area since 1969. It is a strategy used primarily to reduce recurrent freeway congestion that occurs when demand exceeds capacity. This strategy can also be effective in addressing non-recurrent congestion, which occurs as a result of incidents, accidents and non-planned events.

In District 7, Ramp metering is introduced when segments of freeway mainline start to experience increase in traffic volumes, which may lead to congestion and commute delays. To improve this condition, meters are installed at the on-ramps to control the number of vehicles entering the freeway. The metering rate (cycle length) is usually determined based on the on-

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ramp traffic volume, mainline vehicle capacity and ramp vehicular storage. It is initially determined by the traffic engineer, but could increase up to rest in green, if real-time occupancy and volume adjacent to the ramp fall respectively below critical occupancy and volume threshold values set by the engineer. This mode of operation is known as local mainline traffic responsive metering.

Most meters allow one vehicle per cycle per lane; however, it could be programmed to allow 2 or a maximum of 3 vehicles per cycle per lane. This condition is referred to as platoon metering. Platoon meters are generally used for freeway connectors and some on-ramps, where traffic volumes are considerably high. The metering cycle for platoon operation is distinguished by adding a yellow phase to extend the cycle length, when more than one vehicle is entering the freeway.

During congestion peak periods, traffic at the on-ramp might back up to City streets or freeway mainline in case of connectors. To mitigate this condition, the engineer has the option of activating a queue loop, located near the entrance of most on-ramps and all metered connectors. When the queue loop is triggered, the metering rate will gradually increase relieving back up into adjacent City streets or connecting freeway mainline.

In District 7, close to half of the metered on-ramps include a non-metered HOV bypass lane. In some cases, the HOV bypass lane might have to be converted to a metered mix flow lane due to high on-ramp traffic volume. Thus, metering of both ramp lanes provides additional storage capacity. The HOV bypass lane will also be eliminated when it creates a trap lane for single occupant vehicles. The contents of Exceptions to the Ramp Meter Policy fact sheet, including converting or eliminating HOV lanes, are listed in the January 2000 edition, of the Ramp Meter Design Manual (See Attachment 5).

EXISTING RAMP METERING SYSTEM

District 7 serving Los Angeles and Ventura counties, consists of 870 metered on-ramps (See Attachment 1A) and 19 metered connectors (See Attachment 1B), making it the largest ramp metering District in California. The Districts' additional 372 on-ramps (See Attachments 1C and 1D) and multiple freeway-to-freeway connectors are not metered due to lack of funding, geometric constraints, heavy traffic demand or light traffic conditions.

District 7 freeway system is divided into various sections. A lead engineer is in charge of ramp and connector meters in each section. These sections are further subdivided in order to be effectively monitored by different members of the Ramp Metering Branch (See Attachments 2A and 2B).

FUTURE RAMP METERING SYSTEM

District 7 plans to install ramp metering systems (RMS) and deploy System Wide Adaptive Ramp Metering (SWARM) on various sections of mainline freeways. These sections are starting to experience gradual increase in traffic volumes. Some of the proposed RMS locations are programmed to be funded in the 10 year Shopp Plan. Others might be incorporated in upcoming freeway widening or mainline HOV projects. For more details, refer to Future On-Ramp Meters (Attachment 1C) and SWARM (Attachment 6).

EXISTING FREEWAY TO FREEWAY CONNECTOR METERING SYSTEM

The freeway to freeway connector metering system in District 7 has proved to be a successful strategy in reducing traffic congestion. It saves a great deal of traffic delay and reduces traffic collisions by breaking up vehicle platoons entering the freeway. The concept of freeway to freeway connector metering was developed as a tool to regulate extremely high traffic volume connecting from one freeway to another. The strategy for a connector metering system is similar to that of the ramp metering system. However, due to higher speeds and heavy traffic volumes on the connectors, longer storage and advance warning devices are required in order to safely operate the connector meters. By regulating freeway to freeway access, the receiving freeway benefits from an increase in mainline speed contributing to a decrease in the overall travel time.

Connector metering consists of installing signal meter heads and electronic warning devices on the connectors to control the number of vehicles merging onto the freeway. The safety features include a "Meter On" sign, a "Prepare to Stop" sign, a signal ahead warning (W-41) sign with flashing beacons, in addition to overhead and ground mounted traffic signals. There is also a queue override system to reduce excessive queue build up on the connector. Due to longer storage length and specific geometric requirements, the existing connector meters are confined mainly to newer freeways like Route 105 (See Attachment 1B). Thus, on most existing connectors, due to their original design accompanied with inadequate storage capacity and insufficient sight distances, connector metering can not be implemented.

FUTURE CONNECTOR METERING SYSTEM

Currently, with the exception of Route 10 / 605 Interchange, no existing freeway connector locations are proposed for reconstruction. There are several other locations where connector metering would benefit the operation of the interchange. To implement connector metering, however, would require overcoming several issues such as, inadequate storage capacity and

geometric features impacting sight distance. To correct these deficiencies would require partial or full reconstruction of the interchanges. This would make metering implementation cost prohibitive. Any future design involving freeway interchange, however, should include a traffic study to implement connector metering.

STRATEGIC PLAN

Over the past 30 years, multiple traffic control strategies have been used, in conjunction with ramp metering, to maximize freeway efficiency. One of the major achievements in this field was the establishment of a regional Transportation Management Center (TMC), to monitor traffic and respond to major incidents, thereby minimizing non-recurrent congestion delays. In addition, the use of advanced technologies is being developed to control ramp meters in real time and on corridor basis. One of these technologies, currently being deployed in District 7, is System Wide Adaptive Ramp Metering (SWARM) (See Attachment 6). The District shall continue to explore these strategies among others, such as metering HOV bypass lanes on freeway on-ramps in order to more effectively control traffic flow onto the freeway mainline.

In the past, there have been opportunities to include ramp meter systems in major and minor roadway construction projects, during the initial project development phases. Currently, new Ramp Metering Systems (RMS) installation, aside from having their own contracts, are included in freeway mainline widening projects, High Occupancy Vehicle (HOV) projects, in addition to closed circuit television (CCTV) and various communication system contracts.

ATTACHMENTS

METERED CONNECTOR OPERATIONAL INVENTORY

Co.	Rte	Location	DIR	E No.	PM	KP	Ramp Storage (veh)	Platoon Metering (Yes/No)	Veh. / Green/ Lane	Total Lanes	Prepare to Stop Sign	Meter On Sign	Flashing Beacon	Metering Time Monday - Friday	
														AM Period	PM Period
LA	105	NB-405 to EB-105	E	5917	2.50	4.00	170	No	1	2	X	X	X		14:00 - 19:00
LA	105	SB-405 to EB-105	E	5916	2.82	4.51	346	Yes	2	2	X	X	X		14:00 - 19:00
LA	105	SB-110 to EB-105	E	5920	7.55	12.08	165	No	1	2	X	X	X		14:00 - 19:30
LA	105	NB-110 to EB-105	E	5911	7.56	12.10	100	No	1	2	X	X	X		14:00 - 19:30
LA	105	NB-710 to EB-105	E	5905	13.81	22.10	330	Yes	2	2	X	X	X		14:00 - 19:30
LA	105	SB-710 to EB-105	E	5906	13.94	22.30	430	No	1	2	X	X	X		14:00 - 19:30
LA	105	SB-110 to WB-105	W	5912	6.81	10.90	256	Yes	2	2	X	X	X	5:30 - 9:30	14:00 - 19:30
LA	105	NB-710 to WB-105	W	5903	13.01	20.82	364	No	1	2	X	X	X	5:30 - 9:30	14:00 - 19:00
LA	105	SB-710 to WB-105	W	5904	13.21	21.14	100	Yes	3	1	X	X	X	5:30 - 9:30	
LA	110	WB-105 to SB-110	S	5919	13.44	21.50	182	No	1	2	X	X	X		OFF
LA	110	EB-105 to SB-110	S	5913	13.45	21.52	74	Yes	2	1	X	X	X		OFF
LA	110	SB-5 TO SB-110	S	5900	25.41	40.66	250	No	1	2	X	X	X		OFF
LA	110	EB/WB-105 to NB-110	N	5914	14.50	23.20	275	Yes	2	3	X	X	X	6:00 - 10:00	14:00 - 18:00
LA	405	EB/WB-105 to SB-405	S	5918	22.30	35.68	464	Yes	3	2	X	X	X	6:30 - 9:00	14:00 - 19:30
LA	405	WB-105 to NB-405	N	5915	22.40	35.84	282	Yes	3	2	X	X	X	6:30 - 11:00	13:00 - 18:30
LA	605	EB-105 to SB-605	S	5909	7.20	11.52	372	Yes	3	2	X	X	X		14:00 - 19:00
LA	605	EB-105 to NB-605	N	5910	8.20	13.12	318	Yes	3	2	X	X	X	5:30 - 10:00	13:30 - 19:00
LA	710	EB/WB-105 to SB-710	S	5901	15.25	24.40	550	Yes	2	3	X	X	X	6:30 - 9:30	14:00 - 18:30
LA	710	EB/WB-105 to NB-710	N	5903	16.10	25.76	580	Yes	3	2	X	X	X	6:00 - 10:00	14:00 18:30

FUTURE ON-RAMP METERS

Proposed to be metered within the next 10 years				
County	Route	Direction	Location	Post Mile
LA	5	SB	Lake Hughes	59.700
LA	5	SB	Parker Rd.	58.830
LA	5	SB	Hasley Cyn.	56.47
LA	5	SB	Rye Cyn.	55.39
LA	5	SB	Rte. 126	55.3
LA	5	SB	Magic Mountain	53.41
LA	5	SB	Mc Bean Pkwy. EB	51.78
LA	5	SB	Mc Bean Pkwy. WB	51.42
LA	5	SB	Calgrove	48.88
LA	5	SB	Rte. 14	45.1
LA	5	SB	Roxford	42.48
LA	5	SB	San Fernando Mission WB	40.31
LA	5	SB	San Fernando Mission EB	40.05
LA	5	SB	Brand	39.91
LA	5	SB	Chatsworth	39.78
LA	5	SB	Paxton St.	39.14
LA	5	SB	Rte. 118	38.95
LA	5	NB	Paxton St.	39.31
LA	5	NB	WB Rte. 118	39.51
LA	5	NB	San Fernando Mission	40.44
LA	5	NB	Roxford	42.79
LA	5	NB	WB 210	44.333
LA	5	NB	Rte. 14	45.1
LA	5	NB	Calgrove	49.22
LA	5	NB	Lyons	50.43
LA	5	NB	Mc Bean Pkwy.	51.42
LA	5	NB	Magic Mountain	53.65
LA	5	NB	Rte. 126	55.531
LA	5	NB	Hasley Cyn.	56.75
LA	14	SB	Sand Cyn.	R33.397
LA	14	SB	Via Princess Way	R30.722
LA	14	SB	Sierra Hwy.	R30.643
LA	14	SB	Golden Valley	R29.542
LA	14	SB	Sierra Hwy./Placerita	R28.122
LA	14	SB	Placerita Cyn.	R27.876
LA	14	SB	San Fernando Rd.	R26.891
LA	14	NB	Sierra Hwy./Foothill	R25.095
LA	14	NB	San Fernando Rd.	R27.346
LA	14	NB	Placerita Cyn. EB	R28.056

FUTURE ON-RAMP METERS

Proposed to be metered within the next 10 years				
County	Route	Direction	Location	Post Mile
LA	14	NB	Placerita Cyn. WB	R28.274
LA	14	NB	Golden Valley	R29.978
LA	14	NB	Via Princess Way	R31.115
LA	14	NB	Sand Cyn.	R33.592
VEN	23	SB	New LA Ave.	11.211
VEN	23	SB	Tierra Rejada WB	10.355
VEN	23	SB	Tierra Rejada EB	9.924
VEN	23	SB	Olsen WB	8.212
VEN	23	SB	Sunset Hills WB	7.196
VEN	23	SB	Sunset Hills EB	7.005
VEN	23	SB	Los Arboles WB	6.058
VEN	23	SB	Los Arboles EB	5.871
VEN	23	SB	Janss WB	5.093
VEN	23	SB	Janss EB	4.891
VEN	23	SB	Olsen EB	1.903
VEN	23	NB	Hillcrest	3.926
VEN	23	NB	Janss EB	5.053
VEN	23	NB	Janss WB	5.254
VEN	23	NB	Los Arboles EB	6.020
VEN	23	NB	Los Arboles WB	6.219
VEN	23	NB	Sunset Hills EB	7.135
VEN	23	NB	Sunset Hills WB	7.368
VEN	23	NB	Olsen EB	7.903
VEN	23	NB	Olsen WB	8.303
VEN	23	NB	Tierra Rejada WB	10.121
VEN	23	NB	Tierra Rejada EB	10.160
LA	60	EB	SB Phillips Ranch Rd.	28.020
LA	60	WB	Garfield Ave.	5.360
LA	101	SB	Lindero Cyn. WB	37.575
LA	101	SB	Lindero Cyn. EB	37.347
LA	101	SB	Reyes Adobe	36.070
LA	101	SB	Kanan Rd.	34.910
LA	101	SB	Palo Comado Cyn.	33.764
LA	101	SB	Liberty Cyn.	32.552
LA	101	SB	Lost Hills Rd.	31.833
LA	101	SB	Los Virgenes WB	31.253
LA	101	SB	Los Virgenes EB	31.020
LA	101	NB	Los Virgenes	31.100
LA	101	NB	Lost Hills Rd.	32.072

FUTURE ON-RAMP METERS

Proposed to be metered within the next 10 years				
County	Route	Direction	Location	Post Mile
LA	101	NB	Liberty Cyn.	32.906
LA	101	NB	Palo Comado Cyn.	33.798
LA	101	NB	Kanan Rd.	35.2
LA	101	NB	Reyes Adobe	36.3
LA	101	NB	Lindero Cyn EB	37.495
LA	101	NB	Lindero Cyn WB	37.713
VEN	101	SB	Telephone Rd.	25.86
VEN	101	SB	Victoria	24.509
VEN	101	SB	Johnson Dr.	23.501
VEN	101	SB	Vineyard	22.031
VEN	101	SB	Vineyard	21.78
VEN	101	SB	Rose	20.972
VEN	101	SB	Rice	20.032
VEN	101	SB	Del Norte	19.024
VEN	101	SB	Central	17.59
VEN	101	SB	Los Posas EB	15.928
VEN	101	SB	Los Posas WB	15.797
VEN	101	SB	Carmen	14.663
VEN	101	SB	Fulton/Somis	13.913
VEN	101	SB	Dawson/Petit	13.555
VEN	101	SB	Pleasant Valley	12.31
VEN	101	SB	Pleasant Valley	12.25
VEN	101	SB	Camarillo Spring	10.9
VEN	101	SB	Wendy	7.7
VEN	101	SB	Borchard/R.Cornejo	6.89
VEN	101	SB	Ventu Pk EB	6.218
VEN	101	SB	Ventu Pk WB	6.064
VEN	101	SB	Lynn Rd. EB	5.006
VEN	101	SB	Lynn Rd. WB	4.839
VEN	101	SB	Moorpark	3.91
VEN	101	SB	Rancho Rd.	3.06
VEN	101	SB	Hampshire	1.493
VEN	101	SB	Westlake EB	0.632
VEN	101	SB	Westlake WB	0.458
VEN	101	NB	Westlake EB	0.68
VEN	101	NB	Westlake WB	0.786
VEN	101	NB	Hampshire	1.776
VEN	101	NB	Rancho	3.169
VEN	101	NB	Moorpark	4.28

FUTURE ON-RAMP METERS

Proposed to be metered within the next 10 years				
County	Route	Direction	Location	Post Mile
VEN	101	NB	Lynn Rd.	5.168
VEN	101	NB	Ventu Pk Rd. EB	6.186
VEN	101	NB	Ventu Pk Rd. WB	6.308
VEN	101	NB	Borchard	7.232
VEN	101	NB	Wendy	7.86
VEN	101	NB	Wendy	8.067
VEN	101	NB	Camarillo Spring	10.806
VEN	101	NB	Pleasant Valley	12.275
VEN	101	NB	Pleasant Valley	12.396
VEN	101	NB	Flynn Rd.	13.226
VEN	101	NB	Dawson	13.689
VEN	101	NB	Carmen	14.871
VEN	101	NB	Las Posas	15.864
VEN	101	NB	Las Posas	15.987
VEN	101	NB	Central	17.897
VEN	101	NB	Del Norte	19.322
VEN	101	NB	Rice	20.047
VEN	101	NB	Rose	21.062
VEN	101	NB	Vineyard EB	21.966
VEN	101	NB	Vineyard WB	22.179
VEN	101	NB	Wagon Wheel	22.861
VEN	101	NB	Oxnard Blvd.	22.94
VEN	101	NB	Johnson Dr.	23.714
VEN	101	NB	Victoria Ave.	24.797
VEN	101	NB	Rte. 126	26.597
LA	110	SB	Torrance	7.784
LA	110	SB	Carson	6.865
LA	110	SB	223rd St	6.355
LA	110	SB	Sepulveda WB	5.493
LA	110	SB	Sepulveda EB	5.29
LA	110	SB	Pacific Coast Hwy	3.968
LA	118	WB	Glenoaks	13.174
LA	118	EB	Paxton	12.397
LA	170	NB	Vineland / WB Rte. 134	14.704
LA	170	NB	Tujunga / Riverside	15.032
LA	170	NB	Magnolia Blvd.	15.504
LA	170	NB	Burbank Blvd.	16.140
LA	170	NB	Oxnord St.	16.614
LA	170	NB	Victory Blvd. EB	17.191

FUTURE ON-RAMP METERS

Proposed to be metered within the next 10 years				
County	Route	Direction	Location	Post Mile
LA	170	NB	Victory Blvd. WB	17.418
LA	170	NB	Sherman Way EB	18.208
LA	170	NB	Sherman Way WB	18.413
LA	170	NB	Roscoe Blvd.	19.681
LA	210	EB	Yarnell	1.040
LA	210	EB	Roxford	2.140
LA	210	EB	Polk	3.440
LA	210	EB	Hubbard	4.280
LA	210	EB	Maclay	5.090
LA	210	EB	Paxton St.	6.250
LA	210	EB	Osborne	8.010
LA	210	EB	Wheatland	9.610
LA	210	EB	Sunland SB	11.060
LA	210	EB	Sunland NB	11.360
LA	210	EB	La Tuna Canyon	14.410
LA	210	EB	Lowell	15.890
LA	210	EB	Honolulu	15.890
LA	210	EB	Pennsylvania	17.000
LA	210	EB	La Crescenta	17.470
LA	210	EB	Ocean View	18.730
LA	210	EB	Angeles Crest SB	19.890
LA	210	EB	Angeles Crest NB	20.070
LA	210	EB	Foothill	21.010
LA	210	EB	Berkshire	21.650
LA	210	EB	San Dimas	R46.66
LA	210	WB	San Dimas	R46.31
LA	210	WB	Berkshire	21.410
LA	210	WB	Gould	20.420
LA	210	WB	Angeles Crest NB	19.870
LA	210	WB	Angeles Crest SB	19.680
LA	210	WB	Ocean View	17.950
LA	210	WB	Pennsylvania	16.620
LA	210	WB	Lowell	15.310
LA	210	WB	La Tuna Canyon NB	14.240
LA	210	WB	La Tuna Canyon SB	14.050
LA	210	WB	Sunland NB	11.160
LA	210	WB	Sunland SB	10.930
LA	210	WB	Wheatland	9.300
LA	210	WB	Osborne	7.730

FUTURE ON-RAMP METERS

Proposed to be metered within the next 10 years				
County	Route	Direction	Location	Post Mile
LA	210	WB	Paxton St.	5.920
LA	210	WB	Maclay	4.790
LA	210	WB	Hubbard	3.950
LA	210	WB	Polk	3.110
LA	210	WB	Roxford	1.760
LA	210	WB	Yarnell	0.870
LA	710	NB	EB PCH	6.83
LA	710	NB	WB PCH	7.01
LA	710	NB	EB Willow St.	7.81
LA	710	NB	WB Willow St.	8.06
LA	710	NB	Wardlow Rd.	9.16
LA	710	SB	EB PCH	6.803
LA	710	SB	WB PCH	6.801
LA	710	SB	EB Willow St.	7.73
LA	710	SB	WB Willow St.	7.96

NON METERED ON-RAMP

County	Route	Direction	Location	Post Mile
LA	2	EB	Glendale	14.350
LA	2	EB	Newell	15.270
LA	2	EB	Fletcher	15.720
LA	2	EB	San Fernando	16.100
LA	2	EB	Verdugo Rd.	16.860
LA	2	EB	York	17.580
LA	2	EB	Holly	19.160
LA	2	EB	Mountain	20.190
LA	5	SB	Gorman	85.820
LA	5	SB	Quail Lake	81.750
LA	5	SB	Smokey Bear	77.950
LA	5	SB	Vista Del Lago	74.450
LA	5	SB	Templin Hwy.	66.150
LA	5	SB	Olympic & Downey	14.160
LA	5	SB	Triggs	13.030
LA	5	NB	Rosecrans	3.749
LA	5	NB	Slauson & Telegraph	9.700
LA	5	NB	Garfield	10.720
LA	5	NB	Washington	11.540
LA	5	NB	Atlantic & Eastern	12.630
LA	5	NB	Atlantic & Telegraph	13.023
LA	5	NB	Ditman & Indiana	14.803
LA	5	NB	Calzona & Indiana	15.161
LA	5	NB	Fourth St.	17.710
LA	5	NB	State St.	18.410
LA	5	NB	Lake Hughes	59.700
LA	5	NB	Templin Hwy.	66.150
LA	5	NB	Vista Del Lago	74.450
LA	5	NB	Smokey Bear	77.950
LA	5	NB	Quail Lake	81.750
LA	5	NB	Gorman	85.820
LA	10	EB	State	18.808
LA	10	EB	Marengo/Soto	19.309
LA	10	EB	Eastern (to Rte. 710)	20.812
LA	10	EB	Eastern	21.064
LA	10	EB	Ramona (to S 710)	21.250
LA	10	WB	Campus	20.866
LA	10	WB	Herbert	20.056
LA	10	WB	Soto	18.988
LA	10	WB	State	18.420
LA	14	SB	Avenue A	R76.837

NON METERED ON-RAMP

County	Route	Direction	Location	Post Mile
LA	14	SB	Avenue D (138)	R73.840
LA	14	SB	Avenue F WB	R72.034
LA	14	SB	Avenue F EB	R71.850
LA	14	SB	Avenue G WB	R71.030
LA	14	SB	Avenue G EB	R70.848
LA	14	SB	Avenue H WB	R70.030
LA	14	SB	Avenue H EB	R69.848
LA	14	SB	Avenue I	R68.775
LA	14	SB	Avenue J-8	R67.514
LA	14	SB	Avenue K WB	R66.850
LA	14	SB	Avenue K EB	R66.658
LA	14	SB	Avenue L WB	R65.730
LA	14	SB	Avenue L EB	R65.554
LA	14	SB	Avenue M WB	R64.724
LA	14	SB	Avenue M EB	R64.540
LA	14	SB	Avenue N WB	R63.717
LA	14	SB	Avenue N EB	R63.506
LA	14	SB	Avenue P	R61.267
LA	14	SB	Avenue S	R58.085
LA	14	SB	Pearblossom Hwy.	R54.250
LA	14	SB	Soledad Cyn. Rd.	R51.476
LA	14	SB	Santiago Rd.	R50.617
LA	14	SB	Crown Valley Rd.	R48.465
LA	14	SB	Red Rover Mine Rd.	R46.543
LA	14	SB	Escondido Cyn.	R43.482
LA	14	SB	Agua Dulce Cyn.	R39.654
LA	14	SB	Shadow Pines (Soledad Cyn.)	R35.520
LA	14	NB	Shadow Pines (Soledad Cyn.)	R36.019
LA	14	NB	Agua Dulce Cyn.	R40.073
LA	14	NB	Escondido Cyn.	R43.037
LA	14	NB	Red Rover Mine Rd.	R47.131
LA	14	NB	Crown Valley Rd.	R48.808
LA	14	NB	Santiago Rd.	R50.938
LA	14	NB	Soledad Cyn Rd.	R52.524
LA	14	NB	Pearblossom Hwy.	R54.906
LA	14	NB	Avenue S	R58.400
LA	14	NB	Avenue N EB	R63.628
LA	14	NB	Avenue N WB	R63.810
LA	14	NB	Avenue M EB	R64.637
LA	14	NB	Avenue M WB	R64.834
LA	14	NB	Avenue L EB	R65.637

NON METERED ON-RAMP

County	Route	Direction	Location	Post Mile
LA	14	NB	Avenue L WB	R65.823
LA	14	NB	Avenue K EB	R66.660
LA	14	NB	Avenue K WB	R66.870
LA	14	NB	Avenue J	R68.141
LA	14	NB	Avenue I	R69.130
LA	14	NB	Avenue H EB	R69.952
LA	14	NB	Avenue H WB	R70.134
LA	14	NB	Avenue G EB	R70.953
LA	14	NB	Avenue G WB	R71.135
LA	14	NB	Avenue F EB	R71.956
LA	14	NB	Avenue F WB	R72.140
LA	14	NB	Avenue D EB	R73.956
LA	14	NB	Avenue D WB	R74.148
VEN	33	SB	Shell Rd.	2.712
VEN	33	SB	Stanley Ave.	1.566
VEN	33	NB	Main St.	0.398
VEN	33	NB	Stanley Ave.	1.720
VEN	33	NB	Shell Rd.	2.818
LA	60	EB	Markland	6.440
LA	60	WB	Seventh Ave.	14.120
LA	90	EB	Centinela	1.890
LA	90	WB	Centinela NB	1.770
LA	90	WB	Centinela SB	1.590
LA	101	SB	Rampart/Benton	3.248
LA	101	SB	Temple/110	1.326
LA	101	SB	Los Angeles	0.643
LA	101	SB	Commercial Way	0.607
LA	101	SB	Alameda/Comercial	0.606
LA	101	SB	Fourth St.	0.509
LA	101	SB	Vignes/Center	0.433
LA	101	NB	WB Los Angeles	0.131
LA	101	NB	Whittier/6th St.	0.258
LA	101	NB	Vignes/Center	0.456
LA	101	NB	Los Angeles/Alameda	0.910
LA	101	NB	First St.	1.016
LA	101	NB	Broadway	1.191
LA	101	NB	Grand Ave.	1.456
VEN	101	SB	Bates	43.421
VEN	101	SB	Seacliff / Rte. 1	39.044
VEN	101	SB	Solimar	32.592
VEN	101	SB	Rte. 33	30.548

NON METERED ON-RAMP

County	Route	Direction	Location	Post Mile
VEN	101	SB	Front / Chestnut	29.794
VEN	101	SB	Harbor / Seaward	28.643
VEN	101	SB	Seaward	28.322
VEN	101	NB	Main St.	26.925
VEN	101	NB	Seaward	28.604
VEN	101	NB	Oak/Californi	30.329
VEN	101	NB	Rte. 33	30.998
VEN	101	NB	Main St.	31.646
VEN	101	NB	Seadiff / Rte. 1	39.340
LA	105	EB	SB-Sepulveda	0.869
LA	105	EB	Hughes Way/Imperial	0.951
LA	105	WB	SB-Sepulveda	0.278
LA	110	SB	5th St.	22.844
LA	110	SB	Anaheim St.	3.108
LA	110	SB	C St. WB	2.809
LA	110	NB	11th St.	21.850
LA	110	NB	9th St.	22.394
LA	110	NB	8th St.	22.596
LA	110	NB	5th St.	22.973
LA	110	NB	Figueroa	24.057
LA	110	NB	Hill	24.563
VEN	126	EB	Victoria Ave. SB	1.436
VEN	126	EB	Victoria Ave. NB	1.522
VEN	126	EB	Kimball Rd.	2.911
VEN	126	EB	Wells / Rte 118	5.219
VEN	126	EB	Briggs Rd.	8.959
VEN	126	EB	Peck Rd. / Acacia	10.368
VEN	126	EB	Palm Ave.	11.482
VEN	126	EB	10 th. St. (Rte. 150)	12.140
VEN	126	WB	10 th. St. (Rte. 150)	11.954
VEN	126	WB	Palm Ave.	11.279
VEN	126	WB	Peck Rd. / Acacia	10.271
VEN	126	WB	Briggs Rd.	8.841
VEN	126	WB	Wells / Rte 118	4.798
VEN	126	WB	Kimball Rd.	2.607
VEN	126	WB	Victoria Ave.	1.241
LA	710	NB	Atlantic	22.150
LA	710	NB	Washington	22.560
LA	710	NB	Floral Dr.	25.340

ROUTE RESPONSIBILITIES

Afsaneh Razavi (Ramp Metering Branch Chief)

Phone (213) 897-0267

AREA ENGINEER: Wahib Jreij

Phone: (213) 897- 8483

Co/Rte	PM Limits	Limits	Assigned	Ph. Ext
LA-10	18.39/48.30	Route 101 to San Bernardino C.L.	Jreij / Dumaplin	7-8483
LA-14	24.79/77.01	Route 5 to Kern County Line	Jreij	7-8483
LA-57	0.00/12.00	Orange County Line to Route 210	Jreij / Dumaplin	7-8842
LA-60	0.00/30.50	East LA Inter. to San Bernardino C.L.	Jreij / Akramian	7-8483
LA-71	0.30/4.80	San Bernardino C.L. to Route 10	Jreij / Dumaplin	7-8842

AREA ENGINEER: Iqbal Toorawa

Phone: (213) 897- 9133

Co/Rte	PM Limits	Limits	Assigned	Ph. Ext
LA-91	6.01/20.74	Vermont to Orange County Line	Toorawa	7-9133
LA-110	0.00/20.36	Route 47 to Rte 05	Toorawa	7-9133
LA-110	20.36/31.91	Route 05 to end of Freeway	Toorawa	7-9133
LA-110	Connector	(E/W)/B 105 to N/B 110	Benitez	7-1666
LA-110	Connector	E/B 105 to S/B 110	Benitez	7-1666
LA-110	Connector	W/B 105 to S/B 110	Benitez	7-1666
LA-110	Connector	S/B 5 to S/B 110	Toorawa	7-9133
LA-105	0.00/18.14	Airport (LAX) to Studebaker	Benitez	7-1666
LA-105	Connector	N/B 405 to E/B 105	Benitez	7-1666
LA-105	Connector	S/B 405 to E/B 105	Benitez	7-1666
LA-105	Connector	N/B 110 to E/B 105	Benitez	7-1666
LA-105	Connector	S/B 110 to W/B 105	Benitez	7-1666
LA-105	Connector	S/B 110 to E/B 105	Benitez	7-1666
LA-105	Connector	N/B 710 to W/B 105	Benitez	7-1666
LA-105	Connector	N/B 710 to E/B 105	Benitez	7-1666
LA-105	Connector	S/B 710 to E/B 105	Benitez	7-1666
LA-105	Connector	S/B 710 to W/B 105	Benitez	7-1666

AREA ENGINEER: Hanh Pham

Phone: (213) 897- 8772

Co/Rte	PM Limits	Limits	Assigned	Ph. Ext
LA-2	14.08/23.44	Glendale Blvd to Route 210	Pham / Dumaplin	7-8842
LA-134	0.0/13.34	Route 170 to Route 210	Pham / Dumaplin	7-8842
LA-210	0.00/52.00	Route 5 to San Bernardino C.L.	Pham / Dumaplin	7-8772
LA-405	0.00/12.95	Orange County Line to Route 110	Atefyekta	7-9292
LA-405	12.95/21.44	Route 110 to Route 105	Torchin	7-6576
LA-405	Connector	E/W 105 to S/B 405	Benitez	7-1666

ROUTE RESPONSIBILITIES

Afsaneh Razavi (Ramp Metering Branch Chief)

Phone (213) 897-0267

AREA ENGINEER: Hamid Kalkatechi

Phone: (213) 897- 0294

Co/Rte	PM Limits	Limits	Assigned	Ph. Ext
LA-5	26.65/88.61	Rte 134 to Kern County Line	Kalkatechi	7-0294
Ven-33	0.00/5.66	Route 101 to Casitas Vista Road	Kalkatechi	7-0294
LA-101	11.60/38.19	Rte 101/134/170 Int. to Ventura C.L.	Kalkatechi / Atef.	7-0294
Ven-101	0.00/43.62	LA County Line to Santa Barbara C.L.	Kalkatechi	7-0294
Ven-126	0.00/13.24	Route 101 to LA County Line	Kalkatechi	7-0294
Ven-126	0.00/13.24	Route 101 to Hallock Drive	Kalkatechi	7-0294
LA-138	0.00/1.80	Route 5 to Gorman Post	Kalkatechi	7-0294
LA-170	14.57/20.55	Route 101 to Route 5	Kalkatechi	7-0294
LA-10	1.88/18.33	4th Street to East LA Interchange	Benitez	7-1666

AREA ENGINEER: Jack Kao

Phone: (213) 897- 9183

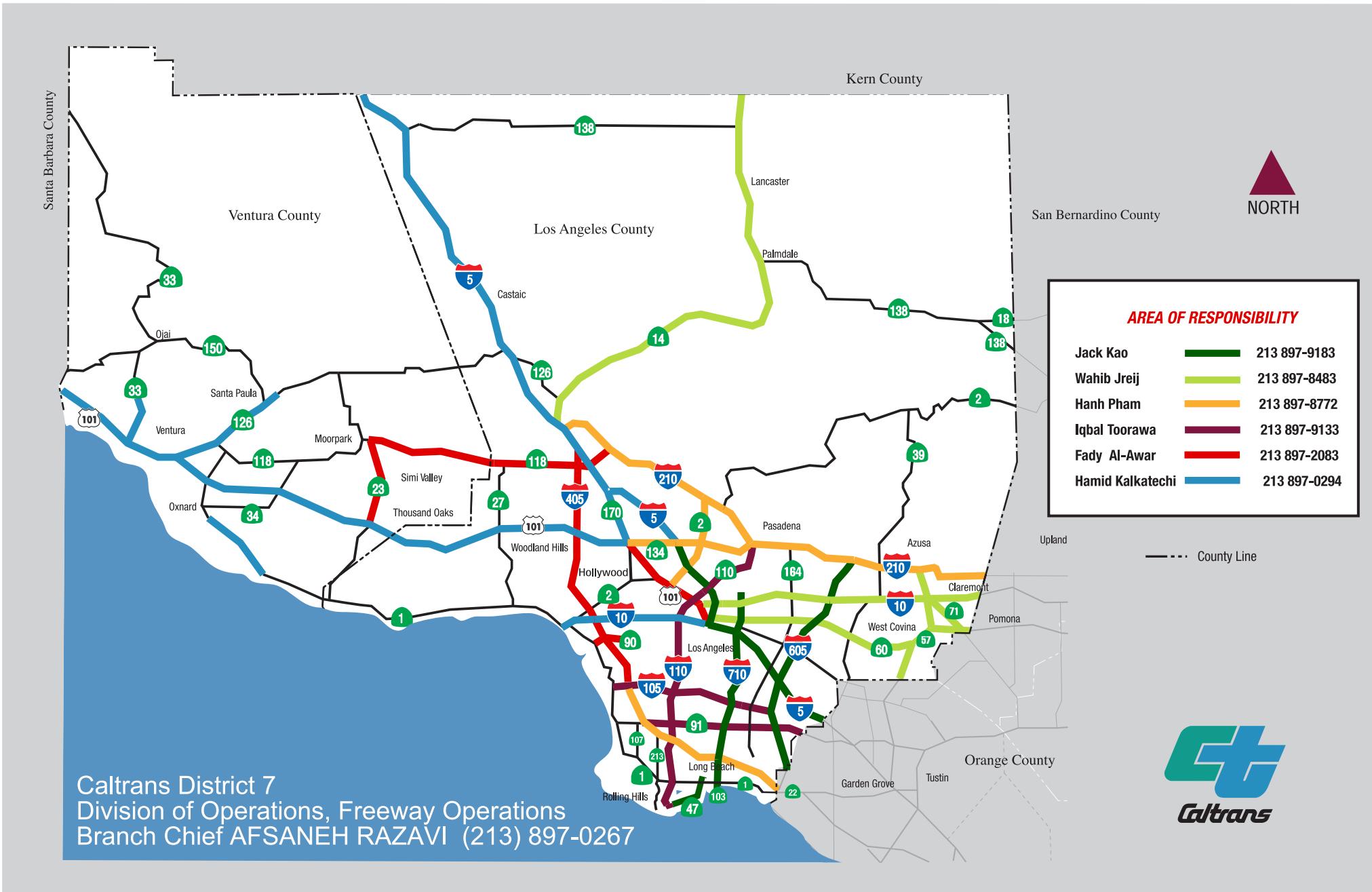
Co/Rte	PM Limits	Limits	Assigned	Ph. Ext
LA-5	0.00/26.65	Orange County Line to Rte 134	Kao / Nguyen	7-9183
LA-605	9.61/26.00	Route 05 to Route 210	Masatsugu	7-6372
LA-605	0.00/9.61	Orange County Line to Route 05	Nguyen	7-2074
LA-605	Connector	E/B 105 to N/B 605	Benitez	7-1666
LA-605	Connector	E/B 105 to S/B 605	Benitez	7-1666
LA-710	6.80/32.70	Route 1 to Route 210	Kao	7-9183
LA-710	Connector	E/W 105 to S/B 710	Benitez	7-1666
LA-710	Connector	E/W 105 to N/B 710	Benitez	7-1666

AREA ENGINEER: Fady Al-Awar

Phone: (213) 897- 2083

Co/Rte	PM Limits	Limits	Assigned	Ph. Ext
LA-101	0.18/11.60	Mission Rd to 101/134/170 Int.	Al-Awar	7-9292
LA-118	0.00/14.08	Ventura County Line to Route 210	Al-Awar	7-2083
Ven-118	18.20/32.60	Route 23 to LA County Line	Al-Awar	7-2083
Ven-23	3.20/11.60	Route 101 to Route 118	Al-Awar	7-2083
LA-405	48.64/39.40	Route 05 to Route 101	Al-Awar	7-2083
LA-405	39.40/21.44	Route 101 to Route 105	Torchin	7-6576
LA-405	Connector	W/B 105 to N/B 405	Benitez	7-1666
LA-90	0.92/3.28	Route 1 to Slauson	Torchin	7-6576

DISTRICT 7 RAMP METER AREA MAP



Attachment 2B

California Department of Transportation
DEPUTY DIRECTIVE

Number:

DD-35

Refer to
Director's Policy: 08-Freeway System Management

Effective Date: 1-3-95

Supersedes: P&P 91-01

Title: Ramp Metering

POLICY

Caltrans is committed to using ramp metering as an effective traffic management strategy to maintain an efficient freeway system and protect the investment made in constructing freeways to keeping them operating at or near capacity flow rates.

DEFINITION/BACKGROUND

Ramp metering is the common method of ramp entry control. It has been an effective tool in reducing congestion on California freeways since the late 1960's. Caltrans has installed over 1300 ramp meters throughout the state and proposes their installation on all urban freeway entrance ramps where metering will improve or maintain effective operations along freeway corridors.

RESPONSIBILITIES

The Traffic Operations Program Manager is responsible for the development, review and dissemination of policies, guidelines, and procedures for ramp metering (see Ramp Metering Policy Procedures).

The State and Local Project Development Program Manager is responsible for the development and review of geometric design standards for ramp metering and supports the inclusion of ramp metering in projects within freeway segments identified in the Ramp Meter Development Plan.

District Directors are responsible for developing local agency support for ramp metering; implementing ramp metering policies and procedures; and providing justification for deviation from established policy and procedures.

APPLICABILITY

Any employees involved with ramp metering activities.

ORIGINAL SIGNED BY

LEE F. DETER
Deputy Director
Maintenance and Operations

Attachment 3

RAMP METERING POLICY PROCEDURES

State of California
Business, Housing and Transportation Agency
Department of Transportation
Traffic Operations
August 1997

Attachment 4

RAMP METERING POLICY PROCEDURES

I. PURPOSE

The purpose of these procedures is to provide guidelines for implementing the Department's ramp metering policy (DD-35).

II. BACKGROUND

Metering has proven to be an effective traffic operations tool to maximize the efficiency of a corridor. The primary objective of metering is to reduce congestion and the overall travel time of the total traffic stream - on both freeway and surface streets. Ramp metering reduces congestion by:

- Maintaining more consistent freeway throughput.
- Utilizing the capacity of the freeway corridor more efficiently.
- Providing incentives for increased use of carpools, vanpools, and public transit by including preferential lanes, which offer timesavings to High Occupancy Vehicles (HOV) at ramp meters.

Secondary benefits include the reduction of congestion-related accidents and air pollution. Ramp meters operate most effectively when upstream mainline traffic is controlled. This control can be accomplished by installing additional ramp meters, metering freeway to freeway connectors or mainline control. These procedures focus on the implementation of ramp metering systems through a coordinated effort involving Caltrans planners, designers, operations personnel, local agency staff, the California Highway Patrol (CHP), and the public.

III. PROCEDURES

- A. It is the District's responsibility to maintain an acceptable level of service on the freeway system, to make the most effective use of each transportation corridor, and to protect the public's investment in the system.

Each District that currently operates, or expects to operate, ramp meters within the next ten years shall prepare a Ramp Meter Development Plan (RMDP) identifying the freeway segments, including freeway to freeway connectors, that are expected to be metered within this period. The RMDP should also identify freeway segments where upstream mainline control is necessary to maintain effective overall freeway operations. The RMDP shall be updated biennially and be included in local Congestion Management Plans.

- B. Projects, which propose the modification of an existing interchange or the construction of a new interchange within the freeway segments identified in the RMDP, regardless of funding source, should include provisions for ramp meters. This applies to all projects that have an approved Project Study Report dated July 1991 or later (the date of the original Policy and Procedure). These provisions, as defined in the Ramp Meter Design Guidelines, should include right of way, geometric to accommodate vehicle storage and HOV bypass lanes, ramp meter equipment, and CHP enforcement areas. Projects which propose additional capacity within freeway segments identified in the RMDP shall include provisions for ramp meters and shall implement the ramp meters at all entrance ramps within the project limits. In freeway segments identified in the RMDP where mainline control is necessary to maintain effective overall freeway operation, additional freeway capacity should not be constructed without an analysis of the operational impacts to downstream segments. Districts are responsible for performing appropriate environmental studies for ramp metering projects.
- C. The District will work in partnership with metropolitan planning organizations; regional transportation planning agencies, and congestion management agencies to program ramp metering projects and develop implementation plans. Coordination and consultation should be documented and concurrence may be obtained in any form the District considers appropriate.
- D. The Ramp Meter Design Guidelines prepared by the Division of Traffic Operations, in cooperation with the Division of State and Local Project Development, and the CHP shall be used when designing ramp metering facilities. This document is a compilation of design information and operational practices used statewide.
- E. HOV preferential lanes shall be considered wherever ramp meters are installed. The need for HOV bypass lanes should be included in the Project Study Report, Project Information Report, Project Report, and Environmental Document. If an HOV preferential lane is not included in a proposal to ramp meter, the reasons should be addressed in the appropriate document.

The District is responsible for consulting with the CHP on project features, which affect enforcement activities such as HOV lane violations, enforcement pads, etc. Coordination and consultation should be documented.

F. When selecting the appropriate metering method for the HOV preferential lane, the following criteria should be used:

Control: An analysis of HOV traffic volumes shall be made to determine the impact on mainline traffic flows. Where adverse impacts exist, consideration should include metering the HOV preferential lane and/or more restrictive metering of the SOV lane(s). Consideration should be given to metering the HOV preferential lane if platoons from local signalized intersections adversely affect the operation of the freeway. Storage capacity and effects to local arterials should also be addressed.

Merge Conditions: Prior to entering the freeway, all vehicles on the on-ramp should be provided with adequate space to safely merge with each other. The safest merge condition is when the speeds of the merging vehicles are identical. When the speed differentials between HOVs and SOVs are excessive, consideration should be given to metering the HOV lane. All ramps should be designed in accordance with the Ramp Meter Design Guidelines, which detail adequate merging distances.

Enforcement: The ability to safely enforce occupancy violations of HOV lanes is essential. The CHP should be consulted for their recommendation of enforcement operations at each HOV preferential lane location.

Corridor Operations: In corridors where ramp meters are already operational, the existing metering method may be used as criteria for additional installations in the same corridor. Should alternate metering methods be proposed along a corridor, local agencies should be consulted.

The criteria listed above can be applied to new and existing ramp meter installations. If it is being applied to an existing ramp meter, the following criteria should also be used:

Accident History: The accident history of the ramp needs to be investigated. If either the ramp or any portion of the freeway within 500 feet of the ramp gore has been flagged as a high accident concentration location (Table C), each accident report should be reviewed in detail to determine whether or not the HOV operation during the metered period was a contributing factor. If evidence suggests that it could have been a contributing factor to the accident, consideration should be given to metering the HOV preferential lane.

- G. Districts shall provide justification for deviation from the policy and these procedures and concurrence shall be obtained from the Headquarters Traffic Operations District Liaison. Deviations from design standards require the approval of the Project Development Coordinator in the Office of Project Planning and Design.
- H. The Division of Traffic Operations provides District personnel with technical assistance and support on the design and operation of ramp meter systems and assists in the preparation of the District's RMDP.

Attachment 4

CONTENTS OF EXCEPTION TO RAMP METERING POLICY FACT SHEET

PROJECT DESCRIPTION

Briefly describe the project. Note the type of project and/or major elements of work to be done.

RAMP METERING POLICY NON-COMPLIANCE FEATURES

Describe the proposed or existing ramp metering policy non-compliance feature(s). (Note: Deviations from advisory or mandatory design standards shall be addressed as required by the *Project Development Procedures Manual*, the *Highway Design Manual* and applicable District Directives.) Design exceptions to standards to be attached to Ramp Meter Policy Fact Sheet.

REASON FOR THE EXCEPTION

Be thorough but brief. Supportive factors may include right-of-way or space constraints, environmental concerns, inordinate costs, etc. Show an estimate of the added cost above the proposed project cost that would be required to conform to the ramp metering policy for which exception is being documented. The estimate does not have to be highly developed but must be realistic.

FUTURE CONSTRUCTION

Describe any planned future projects in the immediate vicinity of the requested ramp meter exception, but do not make any commitments (e.g., ramp metering as part of future projects) unless there is a certainty that they can be followed through.

PROPOSED EXCEPTION REVIEWS AND CONCURRENCE

Note reviews by HQ Traffic Operations, the District Liaison and District Office of Traffic Systems. Give dates of reviews and discuss any comments that were made and their disposition.

REMARKS

Note clarifying remarks. Discuss impacts on project delivery schedule and project costs, if any. Discuss impacts of ramp metering policy non-compliance features.

ATTACHMENTS

Provide a locations map and/or vicinity map for the project, indicating the location of the requested exception(s) to the ramp metering policy. Also provide cross-sections and/or special details as necessary to illustrate the policy non-compliance condition. Letters, resolutions, traffic studies, etc., which help to clarify the reasons for the exception request, may be attached.

SIGNATURE SHEET

The Fact Sheet signature page shall conform to the attached.

Attachment 4

Dist-Co-Rte-KP
Source Unit – EA
Project Cost

FACT SHEET

EXCEPTION TO
RAMP METERING POLICY

(Insert Registered C.E. Seal)

Prepared by:

(Name), Registered C.E.

Date

Telephone

Approval recommended by:

(Name), Project Manager

Date

Telephone

Concurrence by:

(Name), District Liaison
HQ Traffic Operations

Date

Telephone

Approved by:

(Name), District Division Chief,
Operations

Date

Attachment 4

State of California

Business, Housing and Transportation Agency

M e m o r a n d u m

To: DISTRICT DIVISION CHIEFS – Operations
DISTRICT DIVISION CHIEFS – Design
DISTRICT DIVISION CHIEFS – Planning

Date: July 31, 2000

File:

From: **DEPARTMENT OF TRANSPORTATION**
Traffic Operations
Mail Station 36

Subject: Ramp Metering Policy on High Occupancy Vehicle (HOV) Preferential Lanes

The purpose of this memorandum is to clarify and re-affirm the California Department of Transportation (Caltrans) policy on HOV preferential lanes at ramp meter locations. Caltrans is committed to its current policy: **An HOV preferential lane shall be provided at all ramp meter locations.**

The January 2000 edition of the Ramp Meter Design Manual now addresses the circumstances under which exceptions to this policy may be warranted. See 'Modifications to Existing HOV Preferential Lanes' located in Section 'I' of Chapter One:

- Underutilization of an existing lane plus the need for additional right-of-way for storage
- The availability of an alternate HOV entrance ramp within 2 Km
- The availability of a direct HOV access (drop) ramp

Exceptions shall be handled on a location-by-location basis. Conversions may require Federal Highway Administration actions or concurrence. The District Division Chief for Operations, in consultation with the Headquarters Traffic Operations Liaison, is responsible for approving and documenting decisions to remove HOV preferential lanes. These policies and exceptions also apply to new and reconstruction projects. Districts should refer to the "Exception to Ramp Metering Policy" located in the Appendix of the Ramp Meter Design Manual or contact your Headquarters Traffic Operations Liaison for assistance.

Original Signed By

KIM NYSTROM
Program Manager
Traffic Operations

cc: Mr. Robert Buckley
Program Manager
Design and Local Programs

Ms. Joan Sollenberger
Program Manager
Transportation Planning

Attachment 5

System Wide Adaptive Ramp Metering (SWARM)

System Wide Adaptive Ramp Metering, also known as SWARM, is a relatively new ramp meter operating system developed by National Engineering Technology (NET) Corporation. As the name indicates, it adapts the local traffic responsive concept to an entire freeway section or even multiple connecting freeways. However, this system can only be implemented from the traffic management Center through the use of the Advanced Transportation Management System (ATMS). Please note that Swarm is being tested by district 07 and has not yet been implemented on long term basis, similarly to traffic responsive metering.

Types of SWARM

There are three types of SWARM: SWARM 1 operates system wide to predict congestion, SWARM 2a and SWARM 2b operates locally and are based on headway and storage respectively.

- **SWARM 1**

SWARM 1 is system wide adaptive based on a freeway network divided into SWARM sections. Each section begins and ends at a mainline vehicle detection station (VDS) identified as a bottleneck. The SWARM 1 algorithm operates at bottleneck locations and controls the flow of all upstream ramp locations in this section.

Since density is directly related to congestion, it is monitored at each bottleneck location. The algorithm requires a nominal saturation density threshold value for each mainline VDS in the network.

The algorithm attempts to estimate the density n minutes (user settable) in the future. If the estimated density exceeds the bottleneck saturation density, then ramp meter rates will be computed in an attempt to head off the predicted onset of congestion.

Starting at the bottleneck and working upstream, the computer calculates new metering rates based on the required volume reductions. Actual metering rates are subject to maximum and minimum rates. Since reductions may be positive or negative, excess or surplus values are propagated upstream.

- **SWARM 2a**

SWARM 2a is local responsive based on headway (time between consecutive vehicles). It uses density function to compute local metering rates and attempts to maintain headway such that maximum flow can be obtained.

Attachment 6

- SWARM 2b

SWARM 2b is local responsive based on storage. It computes the number of vehicles stored between two VDS stations and compares it to a maximum storage value. Metering rates are computed to maintain level of service (LOS) D as long as possible.

Combinations of SWARM

SWARM can be implemented in 2 or 3 mode combinations; SWARM 1 and 2b, Swarm 1, 2b and 2a or any other combination. The most restrictive rate recommended by any of the Swarm modes will then be implemented.

Advantages of SWARM

- It maximizes traffic flow on the mainline.
- It is responsive to actual traffic conditions throughout the system.
- It is responsive to recurring and non-recurring congestion.

Disadvantages of SWARM

- Ramp control and traffic surveillance devices must be connected to a computerized communications center.
- Communication lines have to be maintained at all times in order for SWARM to operate properly.
- SWARM requires accurate data from mainline and on and off-ramp detectors in order to work effectively.
- It is more complicated than traffic responsive and fixed-time metering.

Attachment 6